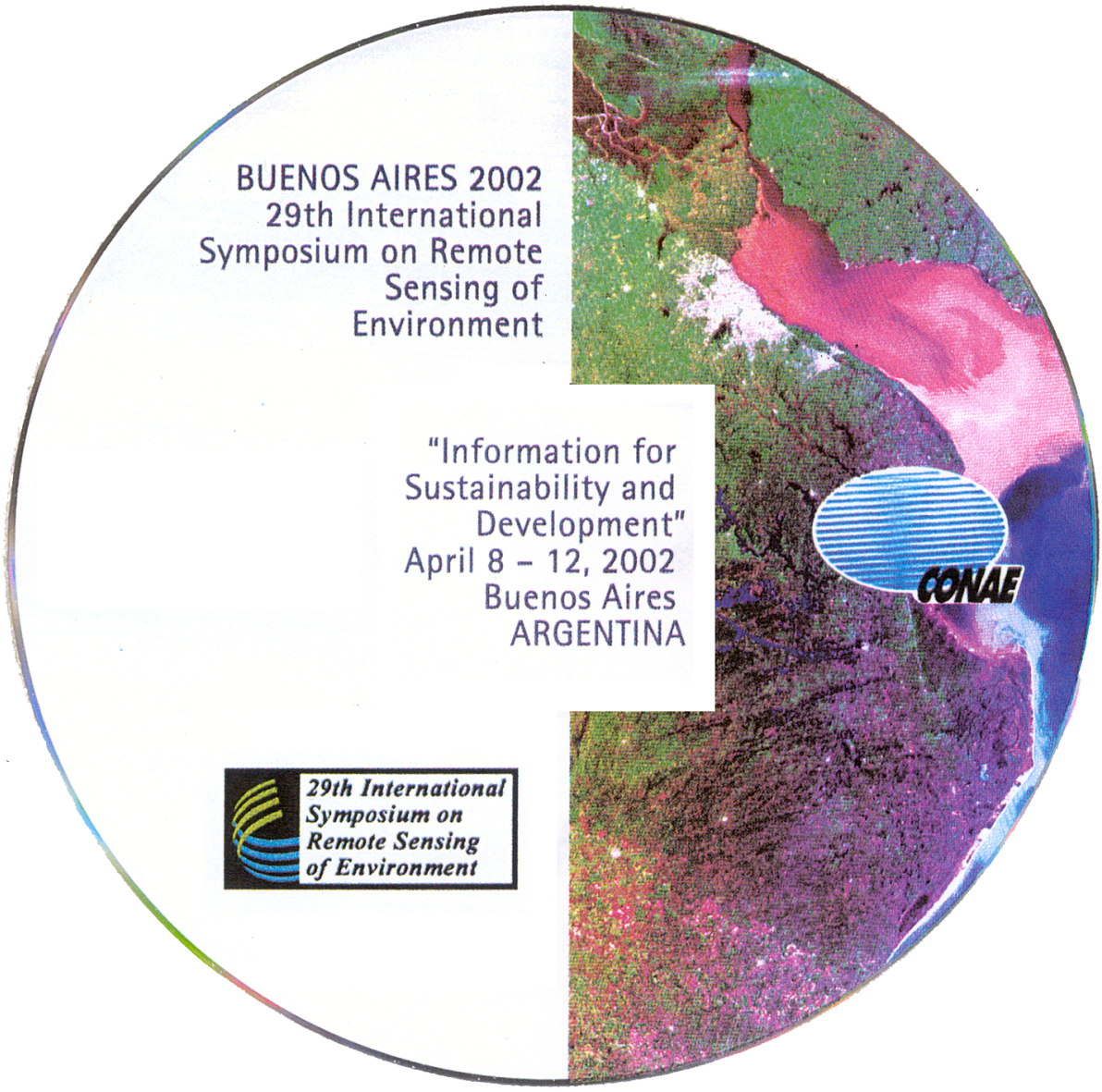
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Seasonal Snow Extent and Snow Mass from 1988 - 2001 in the Patagonia Region of South America Using SSM/I Passive Microwave Data

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ABSTRACT - Seasonal snow cover in South America was examined in this study using passive microwave satellite data from the Special Sensor Microwave Imagers (SSM/I) on board Defense Meteorological Satellite Program (DMSP) satellites. For the period from 1988-2001, both snow cover extent and snow depth (snow mass) were investigated during the winter months (May-August) in the Patagonia region of Argentina. Since above normal temperatures in this region are typically above freezing, the coldest winter month was found to be not only the month having the most extensive snow cover but also the month having the deepest snows. For the fourteen-year period of this study, the average snow cover extent (May-August) was about 0.46 million km^2 and the average monthly snow mass was about 1.18 x 10^{13} kg. July 2000 was the month having the greatest snow extent (8.1 million km^2) and snow mass (approximately 2.8 x 10^{13} kg).

I. INTRODUCTION

Using data from the SSM/I on board DMSP satellites, seasonal snow extent and snow depth (snow mass) have been calculated for the period from 1988-2001 in the middle latitudes of South America. It should be noted that in mid winter approximately 99% of the snow cover in the Southern Hemisphere is confined to Antarctica. The data record shows that South America is the only continent in the Southern Hemisphere (other than Antarctica) where an extensive, non-mountainous, winter snow cover may occur. Therefore, the emphasis in this study is on South America. The objectives of this study are to map the seasonal snow cover during the cold months of the year using passive microwave satellite data and to generate a snow record comparable to the record for North America and Eurasia.

II. STUDY AREA

In southern Argentina, snow may accumulate as early as May and as late as October. Each winter, snow is a regular feature south of about 45 degrees latitude, and in the snowiest years, over 1 million square km of snow has been measured (Dewey and Heim, 1983). A single storm may cover the ground with several hundred thousand km^2 of snow. Snow can fall at locations much further north than expected, and it can even lay on the ground for a few days as far north as 27 degrees south latitude. Snow here is usually confined to elevations greater than 1,000 meters above sea level, where as much as 30 cm of snow has been observed in southern Brazil. In July 2000, freezing temperatures and snowfall in southern Brazil and Paraguay damaged coffee crops (Prohaska, 1976).

Typically, snow cover in southern South America results from disturbances embedded in the westerly air streams. East winds and heavy precipitation during the winter in southern South America are caused by quasi-stationary, high-pressure systems at high latitudes over the western South Atlantic Ocean (Kidson, 1988). These anticyclones block the normally zonal air flow in such a way that normal sea level cyclonic systems are steered around the "high" toward Patagonia (the South American states of Rio Negro, Chubut, Santa Cruz and Tierra Del Fuego). In southeastern Brazil, snow can fall when incursions of polar air from the south push northward, coincident with a weakening of the normally dominant sub-tropical high-pressure belt.

Although snow cover may be significant in South America in terms of its effects on weather, especially temperature and agriculture, it is variable from year-to-year. This is to be expected when accumulations generally are shallow. According to Dewey and Heim (1983), over a 7-year period from 1974-1980, snow cover reached a maximum extent of about 1 x 10^6 million km^2 in 1980, but in 1979, the maximum extent was only about 70% of this amount. For comparison, during the 1980 snow season, snow covered an area about the size of the country of Boliva.

VI CONCLUSIONS

Exclusive of Antarctica, seasonal snow in the Southern Hemisphere is, for the most part, confined to South America. Though snow may fall and even persist on the ground for several days in Africa and Australia, on those continents, however, snow is basically a novelty. This study demonstrates that passive microwave radiometry is especially useful in estimating the snow cover extent and snow mass in areas where clouds are a near-constant problem and where the snow is typically ephemeral. The passive microwave observations show that there are sharp year-to-year differences that exist in the seasonal snow extent over the Patagonia region of South America. This agrees with earlier findings in the work of Dewey and Heim (1983).